Cavity Optomechanics: Backaction-Cooling of Mechanical Oscillators

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The mutual coupling of optical and mechanical degrees of freedom via radiation pressure has been a subject of interest in the context of quantum limited displacements measurements for Gravity Wave Detection for many decades. Recent advances in nano- and micro-mechanical oscillators have allowed observing for the first time radiation pressure phenomena in an experimental setting and constitute the emerging research field of Cavity Optomechanics[1]. In this talk I will describe the advances the Max Planck Institute of Quantum Optics has made in this field. Using on chip micro-cavities that combine both optical and mechanical degrees of freedom in one and the same device[2], radiation pressure back-action of photons is shown to lead to effective cooling[3] of the mechanical oscillator mode. This backaction cooling exhibits many close analogies to the Physics of Atomic Laser Cooling and the case of resolved sideband cooling[4] is discussed. This technique is well known in Atomic Physics to provide ground state cooling. Moreover the ability to monitor the motion of the oscillator with a quantum limited sensitivity[5] of 10^{-18}m/√(Hz) will be presented and cooling of a mechanical oscillator to average occupancy of 63 phonons described. These experiments may allow exploring a variety of predictions of quantum measurement theory and mark a first step towards the quantum nature of the most tangible harmonic oscillator: a mechanical vibration.

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